RESEARCH PROGRAM ON THE TRAINING OF SKILLED MANPOWER

No. 9-B

ELECTRONIC DATA PROCESSING OCCUPATIONS IN A LARGE INSURANCE COMPANY

INSTITUTE OF COMPUTER SCIENCE
McLENNAN LABORATORY
UNIVERSITY OF TORONTO

COMPUTATION CENTRE
McLENNAN LABORATORY
UNIVERSITY OF TORONTO

Department of Labour, Canada,
in co-operation with federal and
provincial government agencies and
other groups

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Research Program on the
Training of Skilled Manpower

NO. 9B--TECHNOLOGICAL CHANGES AND SKILLED MANPOWER: ELECTRONIC DATA PROCESSING OCCUPATIONS IN A LARGE INSURANCE COMPANY

Department of Labour, Canada,
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INTRODUCTION

The purpose of this report is to present a preliminary picture of what has been learned so far about the new electronic data processing occupations: what sort of knowledge and skills the new jobs demand; what sort of work the new jobs entail; what sort of people find their way into these new jobs; how they are selected and trained; and how the people in these jobs feel about their work and future prospects.

The present report should be regarded as an interim report on electronic data processing occupations. The material in Chapter I, which offers a broad statistical picture of EDP occupations and personnel in Canada at the beginning of 1960, is derived from a mailed survey. The material in Chapter II is based on a review of the literature in Canada and the United States on project planners and systems analysts. The material in the subsequent chapters, dealing with the remaining EDP occupations in detail and which constitutes the bulk of the report, is a product of a case study of one large insurance company.

In reading this report, it should be borne in mind that the information in Chapters III to VI relates to the experience of one company. Because of differences in subject matter, equipment and applications, the electronic data processing experience and approach to EDP occupations of any single establishment will reflect problems and experiences which are unique. This qualification would apply to any installation selected for such a case study. It is hoped that information on the experience of individual organizations with EDP occupations, as it accumulates, will be of value to other organizations contemplating or involved in EDP applications. At this stage, however, care should be exercised to avoid interpreting the information in this report as a reflection of 'general practice'.

This report is one of a series of studies carried out under the Skilled Manpower Training Research Program initiated by the Federal Department of Labour, in co-operation with other interested federal and provincial departments and management and union organizations. The research program is under the general direction of the Interdepartmental Skilled Manpower Training Research Committee and its aims and objectives are set out in detail in Report No. 1 of this series, entitled 'Progress Report', issued in June 1957.

One phase of the Skilled Manpower Training Research Program has been the study of technological changes in selected industries and their effects on manpower and training requirements. In this phase of the program, the Committee has been greatly assisted by an Advisory Committee on Technological Change which was set up in 1957.

In the summer of 1958, a decision was made to explore the area of office mechanization and automation. Accordingly, a case study was initiated on the impact of the introduction of electronic data processing (EDP) on a large Canadian office organization. A final report on this study must await the completion of conversion to the new system, and will, therefore, not likely be available before 1962.

In the meantime, it became clear that a more general assessment of the status of technological change in Canadian offices was advisable because it would be some time before the case study results could be made available. Although the impact of office mechanization, in all its forms--including organizational and systems change on clerical, white collar and management occupations--represents the full area requiring investigation, it was decided to concentrate available research resources on electronic data processing, the most recent but potentially furthest reaching of all the changes now occurring in the office employment area.

This research was planned in two stages. The first stage involved the administration of a mailed questionnaire to all known Canadian EDP users at January 1, 1960 to accumulate factual information on the number and types of computers in use, the types and sizes of organizations utilizing computers, the different types of work being done by this equipment, and the number of people employed in the several new occupations occasioned by the new systems and equipment. A report on the findings of this survey was published as Report No. 9A in this series: 'Technological Changes and Skilled Manpower: The Current Status of Electronic Data Processing in Canada (1960)'.

The second stage of the survey was designed to obtain information on the impact of EDP on displacement, employment and unemployment, training and retraining, job content, clerical job mix, organizational structure and management, transfers, special groups--clerical supervisors, older workers, etc., and additional material on the new EDP occupations. These data will be collected through field interviews at a sample number of computer-user establishments.

This report was prepared by Dr. John C. McDonald, under the direction of Mr. J.P. Francis and the supervision of Mr. P. Cohen of the Economics and Research Branch, Department of Labour. The help of those who co-operated in the mailed survey, and the continuing support of the organization assisting with the case study, is gratefully acknowledged.

SUMMARY

1. By January 1, 1960 electronic data processing had created 1,216 new jobs. These included 289 administrators, project planners and systems analysts; 357 programmers and coders; 144 computer operators and tape handlers; 130 computer technicians; and 296 peripheral equipment operators, data typists, tape librarians, etc. More than 75 per cent of these jobs were found to be filled by males.

2. The top level EDP jobs--administrators, project planners and systems analysts--are generally filled from within the organization itself. Those selected for these positions are usually chosen for their subject matter knowledge and experience in methods and systems work. Electronic data processing expertise is usually acquired subsequently. The manufacturers of computing equipment often provide expert assistance in this work. Occasionally, the services of a management consultant will be retained.

3. The establishment under study was successful in recruiting from its own employees the requisite potential skills to plan, program and operate an electronic data processing system.

4. In selecting employees to be trained as programmers, the establishment chose those with a detailed knowledge of the current routines of the several departments that would be affected by EDP. In order to select those with the greatest potential programming ability, a battery of tests was administered to help choose the required 25 members of the programming team. In selecting employees to be trained as console operators and peripheral equipment operators, the establishment tended to choose individuals with wide experience in operating the firm's conventional punch card processing installation. The computer technician trainees were selected for their background and experience in electronics acquired quite apart from their previous occupational roles in the company.

5. Of the programmers, those selected included about equal proportions of older and younger persons. The majority of the programmers were drawn from senior clerical and clerical supervisory positions. About one third of the programmers were university graduates and all had achieved junior matriculation standard. The current trend in selecting additional programmers has been to recruit new employees. This latter group is composed of younger university graduates. The console operators and peripheral equipment operators were young, male employees drawn from intermediate and senior clerical classifications. The console operators were high-school graduates and all the peripheral equipment operators had received considerable high-school education. The computer technicians were older, male, long-service employees drawn from clerical and clerical supervisory positions. These technician trainees were high-school graduates.

6. All those selected for the programming team were given a six-week formal course of instruction by a representative of the computer manufacturer. The console operators were given an eight-week formal course of instruction

by the manufacturer. The computer technicians received an extended five-month formal course of instruction conducted by the computer manufacturer. The peripheral equipment operators, however, learned their new jobs through informal on-the-job training.

7. The programmers felt that the three most important attributes for success in their work were: 1) a problem-solving type of mind; 2) thoroughness and patience; and 3) mathematical ability or aptitude. The computer operators shared this emphasis on a mathematical aptitude and an analytical type of mind, and added that experience in punch card processing was helpful in their work. The computer technicians felt that the key to success in their work was extensive practical experience in electronics. The peripheral equipment operators stressed the need for an extensive Hollerith background.

8. Most of those in the Computer Centre occupations regarded their EDP assignments as more difficult than their previous job assignments. The majority of those in EDP occupations appear to enjoy their new assignments more than any previous job in which they had been employed, because of the scope offered for individual initiative, intrinsic job interest, and the prestige of being associated with the Computer Centre. A minority preferred previously held clerical or machine operating jobs.

9. Aware that only a small proportion of those in the programming group would be continuing permanently on programming work, there was some concern among them about future assignments. However, well over one third of the programmers expressed an intention to make their careers in the EDP field. The majority of the operators and technicians also expressed an intention of continuing permanently in EDP work.

10. The new electronic data processing occupations appear to offer unique opportunities for those key individuals who are selected and trained to fill them. However, it should be remembered that the scope of the main body of this study is limited to a single establishment. Generalizations about EDP occupations drawn from such restricted data could prove misleading.

Chapter I

Electronic Data Processing Personnel

The purpose of this first chapter is to present a general picture of the new electronic data processing occupations in Canada as a setting for a detailed discussion of EDP occupations in a large insurance company. The bench-mark information on which this chapter is based was gathered from a mailed survey of 'The Current Status of Electronic Data Processing in Canada (1960)'.(1)

This survey showed that by January 1, 1960 electronic data processing had created 1,200 new full-time jobs in Canadian business, industry and government and that EDP was playing a large part in the work of an additional 646 people.

Although these new EDP occupations will vary from installation to installation, depending upon the size of the computing equipment acquired, the organizational structure of the individual EDP user and the particular computer applications that are being performed, they can conveniently be described in terms of five main groups.

First there are the administrators, project planners and systems analysts. These are the senior occupations charged with making decisions as to the type of computing equipment to be acquired, the nature and extent of the EDP applications to be undertaken, and with co-ordinating and supervising the work of the installation in operation. On the basis of a detailed study of current routines and procedures, the systems analysts and planners prepare the general directives for conversion to and operation of the new system. Particularly during the extended planning phase, these officials may work closely with the systems representatives of the computer manufacturer and distributor, and may also retain the services of outside consultants specializing in electronic data processing systems.

The second group of new EDP occupations comprise the programmers and coders. The primary function of the programmer is to translate the over-all plan into step-by-step instructions for the computer. This program usually takes the form of a detailed flow chart. The work of the coder is to translate or code the program into the detailed numeric or alpha-numeric language which the computer can digest. Often--particularly in the smaller installations--the programmer will code his own programs. In the larger installations, the programming occupations may be divided into several ranks from chief programmer to programmer trainee. In the case of many of the medium-sized and smaller installations, the occupations of programmer and computer operator may also be combined.

The third group of EDP occupations are the console operators and tape handlers. The primary function of this occupation is to process the various programs through the computer, monitoring the machine in operation and manipulating the various control devices. In the larger installations,

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(1) Refer: Government of Canada. Department of Labour. Economics and Research Branch. No. 9A. 'Technological Changes and Skilled Manpower: The Current Status of Electronic Data Processing in Canada (1960)'. Chapter IV: Computer Personnel. Pp. 22-24.

two operators per shift will attend the computer, changing places at the computer console at frequent intervals. The balance of time may be spent changing the tape reels on the units that provide the input for the system, and keeping logs and records of computer output.

The fourth group of EDP occupations consists of computer technicians. The primary function of the technician is to keep the installation 'on the air' with a minimum of 'down time'. The work is divided into two major parts: (1) regular preventive maintenance, and (2) 'trouble shooting'--diagnosis, repair or replacement of defective elements when the computer 'hangs up' during production. In the large installation operated on shifts, a crew of computer technicians under the supervision of an electronic engineer specializing in computers is usual. In the smaller installations, a computer technician, who may be responsible for several computers at different locations, will carry out the regular checks and be on call in case of trouble.

The fifth group of new occupations comprises the balance of EDP jobs. In a large installation these include peripheral equipment operators, data typists, control clerks, and tape librarians. The function of the peripheral equipment operator is to monitor and manipulate the control devices on one or more pieces of equipment auxiliary to the system such as a high-speed printer, a card-to-tape converter, or a tape-to-card converter. The function of the data typist is to prepare input for the system by transcribing information from source documents directly onto magnetized tape using a typewriter-like device. The function of the control clerk is to route, record and control computer input and output, source documents, program changes, etc. The function of the tape librarian is to arrange, store, receive and dispatch the reels of magnetic tape which contain the input for and output from the system. A large installation may also have one or more additional full-time clerical or secretarial personnel, such as a computer centre receptionist, stenographer, typist, file clerk, mail clerk, or office boy.

The distribution of full-time EDP personnel among these five occupational groups may be seen from the following table.

Table 1--Electronic Data Processing Occupations and Personnel in Canada, January 1, 1960

Occupation	Male	Female	Total
Administrators, project planners, and systems analysts.	277	12	289
Programmers, programmer/operators, and coders.....	309	48	357
Console operators and tape handlers.....	117	27	144
Computer engineers and technicians.....	130	-	130
Peripheral equipment operators, data typists, tape librarians, etc.....	96	200	296
	929	287	1,216

One of the striking characteristics of EDP staffing illustrated by this table is the high ratio of the senior planning, administrative, and programming occupations to the more junior operating occupations. Of the 1,216 full-time jobs, 646 (53 per cent) are those of the former variety.

This table also shows that electronic data processing is a predominantly male world. More than three quarters of the new EDP jobs were filled by men. This difference in sex distribution is even more pronounced in the top level EDP jobs where 586 (90 per cent) of the administrators, project planners, systems analysts and programmers were found to be men. The same tendency holds true for the employment of males as computer operators and computer technicians. It is only at the junior level EDP jobs such data typists, tape librarians, receptionists, etc., that the female complement of the EDP staffs begins to be filled out.

The regional distribution of full-time Canadian EDP personnel is heavily concentrated in the more industrialized and urbanized areas of the country. The Ontario and Quebec regions account for almost 95 per cent of all Canadian EDP personnel; while Ontario alone provides two out of every three full-time EDP jobs. The reason for this geographic concentration of EDP employment in Ontario and Quebec is not only that almost eight out of every ten computers are located in these provinces, but also that all the large computers requiring large staffs are located in these two provinces, for the most part in the cities of Toronto and Montreal. See Table 2.

The distribution of EDP employment among the various industry groups is shown in Table 3. By and large the biggest employers of EDP personnel are those industries with the most computer installations, e.g., manufacturing. The main exception is the insurance companies which rank as the second-highest employer of EDP personnel even though they rank only fourth in number of computer installations. The reason for this is that three of the insurance installations are large computers with large staffs of programming, operating and maintenance personnel.

Table 2--Distribution of EDP Occupations and Personnel in Canada, by Region, January 1, 1960

Occupation	Geographic Region(1)														
	Atlantic			Quebec			Ontario			Prairie			Pacific		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
Administrators.....	-	-	-	86	-	86	174	12	186	13	-	13	4	-	4
Programmers.....	-	-	-	94	12	106	205	32	237	6	4	10	4	-	4
Computer operators.....	-	-	-	52	4	56	61	16	77	2	5	7	2	2	4
Technicians.....	2(2)	-	2	38	-	38	79	-	79	9	-	9	2	-	2
Peripheral equipment operators.	-	-	-	26	38	64	68	155	223	2	7	9	-	-	-
Total.....			2			350			802			48			14

(1) The number of computer installations in each region are respectively: Atlantic--2; Quebec--24; Ontario--48; Prairie--10; Pacific--5.

(2) These technicians are employed at universities with small 'open-shop' installations where there are no full-time programming, or operating staff.

Table 3--Distribution of EDP Occupations and Personnel in Canada, by Major Industry Group, January 1, 1960

Occupation	Industry Group(1)																				
	Manufacturing			Finance, Insurance			Community and Business Service			Public Administration, Defence			Utilities			Transportation			Trade		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
Administrators.....	76	1	77	55	3	58	42	2	44	41	3	44	28	3	31	33	-	33	2	-	2
Programmers.....	116	5	121	63	10	73	46	10	56	26	13	39	24	6	30	32	4	36	2	-	2
Computer operators...	37	5	42	27	3	30	15	11	26	8	6	14	5	-	5	24	2	26	1	-	1
Technicians.....	31	-	31	33	-	33	29	-	29	14	-	14	11	-	11	11	-	11	1	-	1
Peripheral equipment operators.....	19	23	42	23	70	93	2	12	14	20	28	48	17	46	63	13	15	28	2	6	8
Total.....			313			287			169			159			140			134			14

(1) The number of computer installations located in each of the industry groups are respectively: Manufacturing--30; Community and Business Service--26; Public Administration, Defence--13; Finance, Insurance--12; Transportation--5; Utilities--2; Trade--1. For information on the particular industries included in these industry groups, refer to Report No. 9A. THE CURRENT STATUS OF ELECTRONIC DATA PROCESSING IN CANADA.

There are also substantial differences between the employment-creating effects of large computer installations and smaller installations. As can be seen from Table 4 below, the nine large-scale computers (accounting for only 10 per cent of the computer installations in Canada) provide 45 per cent of the EDP employment. One of the reasons for this is that the larger and more expensive equipment tends to be run on shifts, necessitating provision for parallel teams of operators and technicians. At the opposite extreme are some small installations which have no full-time EDP personnel but are used as tools (open shop usage) by engineers, scientists or accountants who do their own programming and operating.

Table 4--Distribution of EDP Occupations and Personnel in Canada, by Size of Computer Installation, January 1, 1960

	Size of Computer Installation[1]								
	Large			Medium			Small		
Occupation	M	F	T	M	F	T	M	F	T
Administrators.....	100	7	107	166	5	171	11	-	11
Programmers.....	139	18	157	158	28	186	12	2	14
Computer operators.....	55	-	55	58	21	79	4	6	10
Technicians.....	60	-	60	60	-	60	10	-	10
Peripheral equipment operators.....	50	115	165	43	78	121	3	7	10
Total.....			544			617			55

(1) The number of computer installations in each size category are respectively: Large--9; Medium--60; Small--20.

A hypothetical staff in a large computer installation in the head office of a large manufacturing firm or insurance company might typically include[1]: 15 administrators and planners; 19 programmers; 8 computer operators; 8 computer technicians; and a staff of 20 peripheral equipment operators, data typists and key-punch operators, tape librarians, receptionists and full-time clerical personnel.

(1) The figures cited are averages of the actual personnel complements of real computer installations.

The actual staff complement of the EDP installation in the large insurance company on which this report is based comprised: approximately 10-15 administrators,[1] project planners and systems analysts; 27 programmers and coders; 5 computer operators; 12 computer technicians; 3 peripheral equipment operators; 3 unitypists; a tape librarian; and a computer center receptionist.

The staff of a medium-sized EDP installation in a business or manufacturing establishment or a government agency might include: 3 administrators and planners; 3 programmers; 1 computer operator; 1 computer technician, full- or part-time; and a staff of 1 or 2 auxiliary personnel.

The staff of a small installation might include: 1 part-time administrator and planner; 1 programmer/operator; the half-time service of an additional employee; and the part-time service of a technician whose work would include the maintenance of at least one other installation.

From the results of the mailed survey data it has been possible to discuss the new EDP occupations and personnel only in the broadest terms--aggregate numbers and distribution among the several main occupational groups; brief descriptions of the functional roles of the various groups in the EDP installation; distribution of EDP personnel by geographic region, major industrial group, and size of computer installation; and hypothetical staff complements of small, medium, and large installations.

The balance of this report contains a more detailed discussion of each of the main electronic data processing occupational groups. With the exception of Chapter II on Planners, the following material is based on a case study of a large Canadian life insurance company.

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(1) Depending on whether one includes the senior executive officer charged with the over-all responsibility for the administration of the new system; the several key administrative positions in the newly created Policy Administration Department, etc.

Chapter II

Planners

Attention in this chapter is focussed on the senior level jobs associated with the planning, installation, and over-all administration of an electronic data processing system. In the literature, these jobs are often described as PROJECT PLANNER and SYSTEMS ANALYST.(1)

In the case study it was not possible to conduct extensive interviewing with the various members of the planning group. Therefore, unlike subsequent chapters in the report, this chapter relies mainly on a review of the Canadian and American literature on project planners and systems analysts.

Project Planner

The project planner is the person in an organization who has the primary over-all responsibility for the introduction of EDP, at least until the new system becomes fully operational. Even after the system is in operation, the project planner may continue as the administrator of the EDP system. In a large organization, where EDP may become a central vehicle for reaching the organization's goals, his job may begin as much as two or three years before the physical installation actually takes place.

In its early stages, this job is basically one of research. The planner must address himself to a number of questions, of which the following are typical examples. What are the goals of the organization? By what methods are these goals being pursued now, and with what measure of success? What changes in methods and/or equipment could be introduced to improve the speed, quality, or cost of realizing these goals? Would the acquisition of an electronic computer provide the best vehicle for the realization of the organization's objectives and, if so, what specific EDP equipment should be acquired?

The work that goes into finding answers to these questions and the production of the report is usually referred to as a 'feasibility study'. Such a report will outline the advantages and disadvantages of alternative systems of meeting the organization's objectives. The recommendations made in such a report may be limited to changes in work flow and personnel resources. Conversely, the report may recommend the mechanization of particular clerical operations using new bookkeeping machines or mechanical accounting and tabulating equipment. Finally, the report may consider the advantages and disadvantages of acquiring an electronic computer installation either to integrate the organization's operations or to perform discrete phases of the company's work.

This job of evaluating goals and methods and recommending changes and improvements, often involving the incorporation of new types of equipment, has a long history in business and industry. In this sense, it is the name rather than the job of the project planner which is new. On the other hand, the advent of the electronic computer has added a new dimension to methods and systems work.

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(1) For job definitions, refer to: 'Occupations in Electronic Data Processing Systems', United States Department of Labor, Washington, D.C., 1959. Pp. 22 and 26.

The project planner must now find answers to an additional group of questions. What job or jobs would the computer be expected to perform? What size of computer would be required to discharge this work? What auxiliary equipment would be required in addition to the computer itself? Of the commercial computers available, what particular equipment would be most suitable? What would such an installation cost? How do these costs compare with current or alternative methods? Would it be better to rent or buy such equipment? What physical and spatial modifications would be required to accommodate such an installation? What personnel resources would be required to operate it? What economies could be expected in terms of reduced clerical salary costs, reduced inventories of supplies and parts, etc.? What non-monetary benefits could be expected in terms of new information for management decision-making, improved customer service, etc.?

When this investigation has been completed, the report together with recommendations growing out of the research will be forwarded to top management for decision. A policy decision will then be taken to accept or reject the plan, or possibly to request more information before a decision is made. If a decision is made to acquire a computer, the job of detailed planning for and conversion to the new system will be initiated.

There appears to be no generally accepted formula for deciding on the selection of the individual who will undertake this responsibility for determining the feasibility of introducing electronic data processing. Usually, he will be a senior official (though not usually the president or top executive) of the organization with many years' experience. The ideal would be to select an individual whose long familiarity with the goals and procedures of the organization has been enhanced by a thorough knowledge of electronic data processing. However, such a combination of attributes in a single individual would be unusual. It is common, therefore, to select a senior officer who has a good over-all knowledge of the organization and a thorough knowledge of the area or areas of the work that will be affected by the introduction of electronic data processing. The project planner will be essentially a subject matter specialist. Normally, the necessary knowledge of the capacity and capabilities of electronic data processing equipment must be acquired subsequently.

The project planner's initial orientation to EDP may be through a short familiarization course for senior executives offered by the computer manufacturer. However, personal initiative and subsequent practical experience in the techniques of electronic data processing will probably be of much greater significance. This will involve the reading of published materials on EDP systems, including books on electronic data processing and manuals supplied by the manufacturers. Such familiarization will also typically involve numerous visits to operating installations, particularly in the same or related fields of work, to talk with colleagues and profit by their experience.

Because an important dimension of his work will involve liaison with others, both within and outside his own organization, and because he may have a sizable staff working under his direction, the project planner

must be a good administrator and possess the sort of personality that works easily with others. Often the project planner will report directly to the chief executive. It is generally agreed that any EDP installation must have the confidence and support of top management in order to be fully effective. Cases may also occur where an outside firm of management consultants is retained to carry out the feasibility study or to assist the project planner in his work.

Systems Analyst

Prior to making the decision to acquire a computer, the project planner may have a small staff working under his direction gathering and analyzing information that may have a bearing on the decision. Once the decision to acquire an electronic data processing installation has been made, it will be necessary to augment this staff to undertake the detailed planning of the new system and conversion to it. It will, perhaps, be convenient to refer to such personnel as systems analysts.(1)

The primary function of the systems analyst is to develop routines of work which will exploit the capacities of EDP equipment. Part of this responsibility involves bringing work to the computer and distributing the computer's output in a smooth, uninterrupted flow. There are two main phases to this work: designing the new system or the new pattern of work flow which will maximize the computer's contribution; and designing a system through which present methods and procedures can be converted to the new system.

This work involves a detailed analysis and first-hand knowledge of the present system and a thorough knowledge of the capacity and capabilities of electronic data processing equipment. Once again, the ideal would be to find individuals who possess a combination of detailed subject matter knowledge and technical competence in electronic data processing. In practice, however, the systems analysts will be selected for their subject matter knowledge and experience in methods and systems work, and will usually be expected to acquire their knowledge of EDP subsequently.

In the case of a large installation there may be as many as six or eight systems analysts. This introduces an element of flexibility into the manner in which the work may be broken up into individual assignments.

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(1) In this report, to make for clarity of exposition, each of the several EDP occupations has been treated as a separate entity. In the case under study, the general rule was that these occupations were functionally as well as theoretically distinct. On the other hand, in the experience of an industrial installation of similar size, systems analysis, programming, and coding were treated as a single occupation. Each of these approaches has its comparative advantages and disadvantages. In many of the medium-sized and smaller installations the latter pattern may be more typical than the separation of functions. The point is that a wide range of occupational combinations will be encountered in EDP installations, each combination tailored to meet the specific requirements of the individual organization.

These systems analysts will typically be selected in such a manner as to bring together a group of individuals whose subject matter knowledge is complementary and whose experience covers the major functional areas that will be affected by the new system. Individual assignments for drawing up detailed plans for the new procedures and working out methods for converting to the new procedures are likely to reflect this subject matter specialization. That is, a prerequisite to designing new procedures is an intimate familiarity with present routines. This work requires constant liaison with departmental personnel and detailed analysis of the current procedures in a particular department or group of departments. If, for example, the particular department under study is the accounting department, the logic of selecting a person with experience in the work of this department is clear. He will already be familiar with a great many, if not all, the procedures of the department and will also know the people in the department.

It will not be unusual, therefore, to find individuals from accounting, production, sales, purchasing, etc., in the group as well as individuals from methods and planning departments. In addition, once the decision has been made to acquire a specific battery of equipment, part of the service rendered by the manufacturer may include one or more EDP experts to work on a continuing basis with the systems analysis team until the completion of the project. Also, to supplement the work of their own systems analysts, the organization may decide to retain the advice of a firm of management consultants specializing in the introduction of EDP systems.

The basic function of the systems analysts is to plan the procedures for the new system in detail. This work may involve changing the format of source documents, working out routines to check the accuracy of the source data before it is converted to input for the computer, and devising routines for spot checking computer output, etc. As well as broader tasks involving redistribution of functions among departments, changing the sequence according to which particular processing routines are carried out, and redistributing personnel resources, the systems analysts work may include such detailed activities as planning changes in physical layout and facilities, recommendations with respect to the training and retraining of clerical personnel, selection and training of staff to fill the new electronic data processing positions, redesigning the system of communications with branch offices, and designing the format according to which the computer output will be produced and distributed, etc.

In a large systems team, there may be some functional differentiation of tasks as well as dividing the job of designing the new system into subject matter blocks. For example, one man in the team may carry the chief responsibility for providing the space and special facilities such as air-conditioning and heavy wiring required by the new equipment. Another member of the team may carry the chief responsibility for the selection and training of the new programming and operating staff.

The systems analysts, in order to design a new system which will exploit fully the advantages of the computing equipment, will need to have a much more thorough understanding of the capacities and capabilities of the EDP equipment than the project planner. In an integrated EDP system all the

operations will be channelled into the computer to be processed electronically, either in whole or in part. It is the job of the programming team to work out the specific routines for processing information in and out of the computer in the most efficient way. However, it is the job of the systems analysts to work out the necessary sequences and priorities to bring the work to the computer and distribute its product in a smooth flow without the creation of bottlenecks and delays. The result is that the systems analysts in addition to short EDP orientation courses will assume the major responsibility for familiarizing themselves with the logic and functioning of the equipment. Their greatest aids in so doing are textbooks and manuals and frequent visits to study operating EDP installations. Some of the systems analysts may also invest the time necessary to take the more extended courses for programmers offered by the manufacturers.

The plans of the systems analysts will then become the blueprints according to which the programmers will work. These plans and instructions may be in the form of written documents or visual flow charts or a combination of these techniques.

It should be realized that there is a great deal of overlapping between these occupations. For example, the project planner might be simply the informal leader of the team of systems analysts. Conversely, since the chief programmer is the primary communications link between the planners and programmers, he may often be included on the team of systems analysts. In some of the larger installations, it has been found that better results are attained if the programmers are allowed to do their own systems analysis work. Certainly, in the smaller installations, the systems analysts and the programmer roles are likely to be filled by the same individual.

It is also not unusual to find that many of these jobs are not permanent, but are assignments discharged on a part-time basis or on a full-time basis for a limited period of time. After the new system is introduced, the project planner may return to his actuarial or accounting position, some of the systems analysts may return to the planning department and others to operating departments where they may fill liaison roles with the Computer Centre.

In order to illustrate actual practice, the case of a real-life situation (an insurance company) is cited below. The story dates back to 1949. At that time a small informal group of senior people in the company began to discuss the idea of converting from a functional (or departmental) approach to a centralized or integrated approach to the administration of ordinary life insurance. At that time there was no computer available commercially which could undertake such an operation. In 1953, after several computers had begun to appear on the market, a small group of three senior officers of the firm arranged to see several of these installations in operation.

Stimulated by the possibilities, a working group of four people was formed, including one of the company officers mentioned above, to carry out a detailed study of the potential advantages of computer applications for the company's own work. The period from 1953 to 1956 was spent gathering detailed information about computer capabilities and their possible application

to insurance work. This information was worked up into a report and discussed in detail with top management in a series of meetings extending over a period of 16 weeks. In May 1956, the President of the company recommended the acquisition of a large-scale computer and appropriate peripheral equipment to the Board of Directors and an order for a computer was placed.

The machinery was delivered in May 1958. The two-year interim period was devoted to detailed planning and programming. At this time planning for the computer was transferred from the Planning Department to a newly created department--the Electronic Planning and Processing Department. One of the senior actuaries of the company was seconded from the Actuarial Division to become head of the new department. This role might be equated with that of project planner. The head of the new department reported to the secretary of the company.

In addition to the project planner, there were six members seconded to the new department who might be described as systems analysts. These included the head of the Planning Department--an actuary, oriented to systems and methods; a young actuary, later to become the head of a new department--the Policy Administration Department--which would integrate the functions of five former departments and be the computer's chief consumer; a company officer with a broad background in branch office work; the head of the Accounting Department who is a chartered accountant; a head office man with experience in branch office accounting work and a background in punch card accounting; and a man with a background in policy loan and planning department work. While each of these individuals had his own sector of the planning work to discharge, one of the primary vehicles used for planning work was frequent meetings as a committee. Another function of the planning group, assisted by the Personnel Department, was the recruitment of a staff of approximately 25 programmers. The two chief programmers also fulfilled a liaison function in communicating and interpreting the directives of the systems analysts to the programmers. Indeed, it is a question whether the two senior programmers would more appropriately be classed as systems analysts or programmers.

In this connection, it is interesting to distinguish between the group of programmers working on the combined approach to the processing of ordinary life insurance and the group responsible for programming the several 'service' functions such as mortgage accounting, investment accounting and mortality studies. The systems analysis for the first group was carried out by the committee described above. The second group, however, was largely responsible for carrying out its own liaison and systems work with the departments involved as well as for the programming per se.

Once the planning and programming of the new system has been completed, a new Policy Administration Department will be created which will absorb the functions and a portion of the personnel of the five operating departments whose work has been converted to electronic data processing. The Computer Centre itself will be consolidated with the Hollerith Department and will be administered by the officer in charge of the Hollerith Department. The systems analysts and programmers will be redistributed throughout the organization--a small group of eight or nine will remain in the Electronic

Planning Department to continue planning and programming work; several will occupy supervisory and liaison roles in the new Policy Administration Department; and the others will take up a variety of positions throughout the organization.

Chapter III

Programmers

The occupational information in this and subsequent chapters is based primarily on data concerning the programming and processing of insurance applications in a single establishment.(1) Most of the data were obtained from interviews with those actually working in the new occupations.

As programming for electronic digital computers is a new occupation, a description of it must be regarded as tentative and subject to modification as this field develops and crystallizes. A further qualification that should be borne in mind is that, while the fundamental content of the occupation will be the same from establishment to establishment, differences in subject matter and application may result in some variation in the occupation between establishments.(2)

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(1) The company commenced business in the latter half of the nineteenth century and today has nearly $10 billion of life insurance in force. Its annual sales for the past two years have exceeded $1 billion of insurance and its contracts cover a wide range from individual life to group pension plans. The company is represented in over twenty countries and has 175 Branch and New Business offices. It transacts business from coast to coast in Canada and 70 of its Branch offices are located in this country. At its Head Office the company has a staff of approximately 2,000 engaged in administrative and clerical work, and of this number some 50 per cent work in departments which are, or will be, affected in some way by the computer operation. Of these, about 60 per cent work in the departments that are presently concerned in the various operations noted below, and in consequence quite large scale transfers of staff have already been made between departments. The company is using the computer in the operations performed in connection with its ordinary insurance, group assurance, annuities, and its investments in mortgages and other fields. In addition, the computer is used for payroll, mortality studies, and for various mathematical research surveys.

(2) For example, when the major programming was carried out in the installation under study, little automatic programming assistance was available to the insurance business. Since that time, however, considerable progress has been made in building up and distributing libraries of compiler type programmes that are particularly well adapted to certain common business procedures such as accounting, accounts payable and receivable inventory, etc. Such automatic programming not only holds a potential for speeding up and cutting down the costs of EDP applications, but has the added advantage of avoiding the confusion often encountered when one programmer attempts to follow the logic used by another programmer.

The group of 27 programmers at this installation was divided into two sub-groups, each under the supervision of a senior programmer(1): 15 assigned to the task of programming 'combined operations' on ordinary life insurance policies; and 12 to programming several 'service applications'.(2) The combined operations group was, in turn, divided into two teams: five to program the conversion to the new system, and nine to program the new system itself. The second group of 12 programmers was divided into teams of two or three members to program the various service applications such as mortgage accounting and investment accounting.

The programmer must be familiar with or have access to detailed knowledge of the current status and operation of the specific procedure or procedures he is to program for conversion to and operation on the electronic data processing system. In addition, he must have a detailed working knowledge of the capacity and capabilities of the electronic digital computer and peripheral equipment.

Job Description

As an aid to understanding the work of the computer programmers, the following tentative job description is offered:

> Proceeding according to the plain language or flow-charted instructions of the systems analyst or project planner, the programmer's role is to prepare detailed instructions according to which data may be converted to and arranged in

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(1) The senior programmers were raised from the status of chief clerk to company officer during the course of this research. This may well be a typical illustration of the 'upgrading effect' experienced in the more senior EDP occupations.

(2) The main application for the computer is the integrated processing of the company's ordinary life insurance business. This 'combined operations' application involves transferring the data on individual insurance policies from the various departmental ledger and punch card records, and integrating this information on magnetic tape; using the computer to perform the periodic calculations pertaining to premiums, loans against policies, dividends to policy holders, etc., and up-dating the information on the status of individual policies; at the same time, performing the computations necessary to produce the accounting, statistical and actuarial data required for a variety of studies and statements; and printing premium notices on a high-speed printer. While such a combined operations approach to data processing is designed to exploit fully the potential of an electronic computer, it is a very complex application to plan and program. The alternative approach to computer utilization is the payroll type of application where the computer is simply used to carry out discrete current functions faster and more efficiently. Although combined operations were the justification for the acquisition of the computer, once acquired, it then became economic to utilize it for various 'service functions' such as investment accounting, mortgage accounting, and mortality statistics. A combined operations approach to the group side of the company's business is also being planned for the future.

sequence for the computer, and to prepare step-by-step instructions according to which the computer may carry out the various sequential operations required in processing such data. The preparation of such instructions may be in the form of detailed or simplified flow charts.(1)

The programmer may then proceed to code his program or may turn the coding work over to a coder or assistant. The coder need only be able to interpret the flow charts or other instructions provided by the programmer and be familiar with the codes acceptable to the computer. The role of the coder is to translate such instructions and input data into the digital machine language according to which the computer carries out the necessary manipulation of the data. When coded, the programmer tests his program on the computer, using either actual or test data. This testing involves the relative ease or difficulty with which the computer accepts and discharges the program and an examination of the output for accuracy and completeness. Any mistakes or deficiencies in the program must then be rectified. This process is referred to as 'de-bugging'. There is an almost infinite number of ways to program a particular routine through the computer and achieve a correct result and the greatest responsibility of the programmer is to find the way that is most efficient in terms of machine time. Depending on the nature of the subject matter and on the scope and complexity of the application, programming may vary widely in level of difficulty and responsibility.

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(1) In formal courses of instruction, programmers are taught to write out their instructions in the form of detailed flow charts. On the job, however, each individual appears to develop his own 'best way'. Different sorts of short cuts are developed by different programmers and some even develop whole programs in their heads and proceed to code them directly. Among the programmers interviewed, there were 'the flow charters' and those who derided flow charting. The most common expedient appeared to be the abbreviated flow chart--a sort of programmer's shorthand. In a complex application, this lack of conformity creates problems because it is difficult for anyone other than the individual programmer to trace the logic he has followed in developing a particular program. Recently, a variety of developments in the 'automatic programming' field have occurred which may simplify and speed up programming. Indeed, it has been suggested that accumulated programming experience and routines of wide application, coupled with 'teaching' the computer to code programs into machine language, may doom this new occupation before it is fairly launched. However, as a great deal of hand optimizing and 'custom programming' is necessary to work out the most efficient application, using even the most advanced of these new tools, a more likely effect is that in future programming staffs will be smaller, a good deal of clerical drudgery eliminated from the occupation, and the skill level of the occupation raised.

In the group of 27 programmers interviewed, there was no formal occupational distinction drawn between programming and coding. Although in practice some specialization of task took place among individuals, the general rule was that each member of the group accepted a share of the more difficult programming and more routine coding work.

In the group of programmers as a whole there was a group of younger programmers who had enjoyed more extended formal education and who became very proficient in programming techniques and a group of older, long-service clerical employees who, in addition to programming, brought with them a detailed knowledge of the insurance subject matter to be programmed. For specific programming assignments members from each of these groups tended to be 'teamed' together. In so far as it is possible to generalize, it is felt that the first group mentioned had the best potential as career programmers, while the tendency for the older programmers on completing their assignments was to return to operating departments to fill computer liaison roles in which they utilized their new knowledge and skills.

Characteristics

The establishment had decided to recruit the necessary programming potential from among its own employees and this decision proved to be successful. It was considered more efficient to teach insurance specialists the relevant programming techniques, than to teach the insurance business to externally recruited programming experts. Secondly, such a policy was considered preferable in terms of general staff morale. In terms of age, the programmers split, approximately half being under 40 years of age and half over 40.(1) Twenty-two of the programmers were men and 5 were women. In terms of classification, the majority of the programmers selected were drawn from senior clerical and clerical supervisory positions. One third of the programmers were university graduates and all those selected had achieved junior matriculation. More than three quarters of the programmers had ten or more years' experience in the company, and for half those selected, employment with this firm represented their first and only employment.

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(1) With respect to the selection of new or additional programmers, however, once the conversion had been accomplished, the trend has been to recruit younger personnel with university training.

The programmers felt that the chief characteristics that contributed to success in their work were: a logical approach to problem solving; thoroughness, accuracy and patience; and a mathematical aptitude.(1)

Selection and Training

After the decision was taken to acquire a large computer, a slate of approximately 100 candidates was drawn up with the intention of selecting a team of approximately 25 persons to be trained as programmers. These prospects were then given a series of tests covering (1) mathematics, (2) language, (3) relationship of symbols, and (4) mechanical comprehension. As explained by one of the company officers, the selection was then based on the need to include a broad selection of people with experience in and detailed knowledge of the various parts of the company, a balance of older and younger people, men and women, those with longer and shorter experience in the company, and availability to leave their present positions.

About three weeks after the selection test, the formal programming training course began. This was a six-week course offered on the premises of the company by an instructor on the staff of the computer manufacturer. There was no large-scale computer on the premises at this time. The course consisted of a combination of theory and practice--lectures and problems. The syllabus and general approach followed the programming manual published by the computer manufacturer. The first part of the course was devoted to lectures describing the computer and the logic of its functioning. The main part of the course was devoted to instruction in programming--how to flow chart and how to code. This was handled on a practical problem basis. The application chosen was a payroll problem. Each member of the group was assigned the common problem and proceeded to program it with a certain amount of group and individual coaching by the instructor. The advantage of the payroll problem was that it represented an accounting problem common to various types of establishment and more or less familiar in its subject matter to most employees. It was a nice compromise between being simple

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(1) It may be that the need for an advanced knowledge of mathematics tends to be overstressed by those in the new EDP occupations. Undoubtedly a sophisticated knowledge of mathematics would be prerequisite to programming many scientific and engineering applications. But in a large business-type data processing installation probably one or two highly qualified mathematicians would be sufficient. In an insurance company, for example, at least one person associated with the installation should be thoroughly familiar with the mathematics of actuarial science; in an industrial installation, it might be appropriate to have a senior person qualified as a chartered accountant. The majority of those in the programming group, however, will use arithmetic rather than advanced mathematics as their common operational tool, and this arithmetic ability will be of secondary importance to the logical ability required to approach their problem in a systematic, economical fashion. This comment should in no way be construed to impugn the usefulness of a mathematical aptitude as a selection criterion for EDP occupations.

enough to grasp as an integrated whole and complex enough to demonstrate a wide variety of steps involved in programming for a computer. Some of the programmers, however, felt that an insurance problem would have been more relevant.

The formal six-week training course was followed by two weeks' additional training, supervised by the two Chief programmers. This consisted of practice in programming actual insurance applications. These assignments, referred to by the programmers as their 'thesis problem', were routines in a simplified combined operations application. The programmers worked at their problems in pairs. Subsequently they were taken to New York City in groups of eight to see their programs run on a computer. Each programmer had a very short turn at running his program on the computer and they brought back their output so that they could analyze the deficiencies in the program, and work out de-bugging routines.

The formal training program had extended over a period of two months. However, it was generally agreed that eight weeks' formal training had not produced fully qualified programmers. In the months that followed it is difficult to describe the extended training process that took place other than to say that formal instruction gradually gave way to informal practice programming and on-the-job training and that practice in turn developed gradually into programming for production. One of the strongest reactions of the programmers themselves to the subject of training was that while a formal training program was a necessary preliminary stage, it could not compare with actually 'doing the job' as an environment for learning. One respondent expressed this general feeling when he said:

> 'It was only when we began working on the computer that we really began to learn.... On work of this sort you can't beat the practical experience.'

One of the reasons why the major responsibility for training currently falls on the computer manufacturer is that a company converting to electronic data processing is faced with an immediate problem of training relatively large numbers of raw recruits. By the time that the establishment has developed the potential within itself to train new recruits, the company's need for programmers may have begun to decline.

Attitudes Toward Programming

Twenty-two of the programmers felt that their new work was more difficult than previous jobs they had held in the company. The common reason given was that most previous jobs--ranging from simple to complex--had involved a routine which, once learned, became more or less automatic. These routines could be administered by reference to written policy directives and regulations with the result that only the exceptional cases required study and decision-making or referral. Programming work on the other hand constitutes a continual learning and creative process in which analysis and decision-making is the rule rather than the exception.

Twelve respondents said that they liked their present work better than any previous job they had had in the company, stressing the scope for individual initiative, relative independence of action, and intrinsic interest

and satisfaction in the work. Fifteen programmers said that they had enjoyed previous jobs as much or more than their present assignments. In order to interpret this finding, let us suppose that in order to find maximum satisfaction in work the average individual requires a balance of developmental opportunity and stability. That is to say, the ideal job will, on the one hand, pose new problems demanding individual growth, imagination and ingenuity. These challenges to initiative may involve dealing with people, manipulating abstract ideas, or interpreting and arranging concrete things. A concomitant of this aspect of task is a relatively high level of tension which, if too high, may induce frustration or anxiety. On the other hand, the ideal job will be balanced by a large element of the familiar, repetitive and routine where decision-making tends to be pro forma and satisfaction is derived from short cycle task completion. A concomitant of this aspect of task is monotony which, if unrelieved, may degenerate into chronic boredom and apathy. In the majority of jobs in real occupational life, however, these two elements are found in unequal proportion. In programming work there appears to be an unusually high proportion of the problem-solving element just as in many clerical and supervisory jobs the routine production element predominates. Therefore, it might be assumed that those individuals whose preference was given to programming after two-and-a-half years' experience in this work have a temperamental structure that enjoys problem solving and can carry a high level of tension without suffering undue frustration.

Attitudes Toward Future

Looking towards the future, the company was quite aware that, after the big initial job of programming was completed, it would not be possible to justify continuing such a large group in programming work. And, of course, not all of the members of the team would necessarily wish to continue in programming. With this in mind, the company had adopted a policy that no immediate promotions would result from selection for programming work and that about two thirds of the programming personnel would be technically on loan from their old departments. The intention of the company was to clarify promotion policy with regard to EDP occupations after a short interval which would be used to accumulate information and experience with the new jobs and evaluate them in the context of the firm's job grading system. The most likely development for the future seemed to be that a small programming group of eight or nine people would be retained to program new applications and revise current programs. The balance of those on the programming team would be dispersed to other jobs in the establishment. Quite a few of the older programmers took it for granted that they would be returning to their old departments or moving into the rapidly expanding Policy Administration Department when their contribution to the new system was completed. With a few exceptions, they seemed quite content with this prospect though they felt that they had acquired additional knowledge and skills that should be appropriately rewarded. Many of the individuals in the group in various informal ways had acquired a pretty good idea of whether or not they would be continuing on as programmers. But there was still room for speculation, uncertainty, and some worry.

Any organization adopting electronic data processing should expect to encounter some personnel difficulties. With respect to programmers, one of the problems stems from the fact that a much larger group may be required

to convert to the new system than may be needed as a continuing component in the organization. The result is that if there are programmers who are surplus to the modest requirements of the permanent group but who may yet wish to continue in programming work, they must either: (a) accept reassignment to another position in the establishment, where their programming experience may be utilized to a greater or lesser degree; or (b) seek programming work outside the establishment, for example, with another organization that is entering the electronic data processing field.

Chapter IV

Operators

At present the establishment employs a staff of five computer operators. This staff includes the chief computer operator and his assistant who supervises the second shift. At the moment, the Centre is being operated on a shift-and-a-half basis. There are always at least two operators available at any one time in the Computer Centre.

The computer operator must have a working knowledge of the capacity, capabilities and functional logic of the electronic digital computer. In addition, the operator should be familiar with the general concept of computer programming.

Job Description

As an aid to understanding the work of computer operators, the following tentative job description is offered:

> Proceeding according to instruction sheets provided by the programmer, the computer operator's role is to control and direct the operation of the main computer and 'on-line' components by manipulation of the computer console. This involves readying the equipment for operation, starting it, monitoring its operation, and taking prompt corrective action in stop and error situations. In detail, the computer operator's role involves studying instructions for the run to be processed, mounting the appropriate instruction and input tapes on the tape units, setting appropriate controls on the console, clearing the machine registers and memory, starting the computer into operation, monitoring the computer in operation by observing the neon lights on the control console, answering the computer's interrogations by typing in the required information on the control keyboard, attempting to determine and correct the cause of stoppage or error when such situations occur, reporting to supervisor or consulting with programmers and/or computer technicians when stoppage or error situations are beyond his competence to rectify, taking steps to recover or re-run programs after stop or error situations have been rectified, dismounting and distributing input and output tapes, and filling out required clerical records such as production logs. Action in stop and error situations is the crucial part of the computer operator's job, both in terms of the importance of the consequences of his response and in terms of the knowledge and judgment required to determine the correct response.

In practice these tasks are shared on any one shift by two operators. The practice of having a stand-by operator is dictated by the large cost involved in operating a computer installation. The two operators take turns operating the console and the free operator mounts and dismounts tapes for his team mate.(1)

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(1) In some installations, particularly larger installations, 'tape changer' or 'tape handler' will be a separate occupation rather than being combined with console operator.

Characteristics

All the computer operators were recruited from within the establishment. Apart from the chief computer operator, who is a long-service company employee, the operators are all young men under 30 years of age, drawn from senior clerical and clerical supervisory grades in the company's classification system and who had all previously worked in the Hollerith Department. The average level of education attained by the operators was secondary school completion. The chief computer operator had over 30 years' service in the company and the other four operators between 5 and 10 years' service. The operators found that the chief characteristics contributing to success in this work were: a mathematical aptitude, experience in punch card accounting, a problem solving type of mind, mental alertness, accuracy, manual dexterity, and steady nerves.

Selection and Training

All the computer operators attributed their selection to their previous experience as programmer/operators of the medium-sized computer(1) and to their previous extensive experience in operating conventional punch card machinery. No formal aptitude testing was used in selecting computer operators.

The formal training course preparatory to large-scale computer operating was an eight-week course conducted by the computer manufacturer in New York City. The classroom instruction covered theory and computer logic, programming, operating instructions and binary arithmetic. The practical part of the course consisted in practice operating on a large-scale computer on the premises of one of the customers (a large utility company) of the computer manufacturer. This practical work took place three nights a week from midnight to 7 a.m. for a period of five weeks. The classes were small (6-12) and each member was afforded about 12 hours actual operation of the console during the course. The first member of the group to take the course was the chief computer operator and the other four operators took the course in two groups. Prior to the delivery of the computer at the firm, all five operators travelled to St. Paul, Minnesota for four days' experience on a new model of the computer. This was a 'sort of conversion course for operators'. This time each operator was afforded about one-half hour's practice a day (night) at the console of the computer.

On the whole, the operators reported that they did not find the course too difficult, that the level of instruction was good, and that their previous formal training on the medium-scale computer helped them a great deal in following the more advanced course. However, each of the operators added that they were continuing to learn on the job and that even after eight months' experience they were still acquiring new skills and techniques.

Attitudes Toward Computer Operating

Only two out of the five computer operators felt that their new work was more difficult than their previous assignments, programming and operating the medium-scale computer. As one explained:

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(1) Refer to Appendix.

> 'On the operating side, the (large) computer is considerably more difficult than the (medium-scale) computer. But on the (medium-scale) computer we also had to do programming which we don't on the (large) computer. So they more or less cancel each other out.'

Although all the computer operators welcomed their selection and regarded it as a promotional opportunity, after eight months in the new work two of them looked back on their work on the medium computer as more interesting because it involved programming. Their specific complaint about their present assignment was that there wasn't enough work to do when one wasn't operating the console and 'time drags a bit'.

Attitudes Toward Future

All the computer operators expressed an intention to make their careers in the electronic data processing field. As one expressed it:

> 'In this century it's one invention after another and in this work I feel that I am going along with it and not being left behind the times.'

As far as future progress was concerned the computer operators saw their promotional opportunities in terms of moving up into supervisory roles in the Computer Centre.

Chapter V

Technicians

The maintenance and repair of the computer and peripheral equipment are provided by the computer manufacturer. In addition to the staff of nine manufacturers' resident engineering and technical personnel,(1) the company selected three of its own employees to be trained as computer technicians.(2) These men were regarded by the firm as a nucleus technical staff to which a larger technical group could be added, should the company subsequently decide to assume responsibility for the maintenance of the computer.

On the basis of the pattern of working and future commitments against the computer's time in late 1959, it seemed reasonable to predict that the computer would be run on more than a single shift basis when the installation went into full production. The night shift would probably continue to be reserved for preventive maintenance but whether or not a full second production shift would develop was uncertain.(3) This meant that the computer technicians would be required to do at least some night work. At the present time, the company technicians are allocated one to each shift and the shift assignments are rotated at periodic intervals.

The computer technician requires an extensive formal background and practical experience in electronics. He must be thoroughly acquainted with the capacity, capabilities and functional logic of the computer and with the electronic circuitry, electric and mechanical functioning of both computer and peripheral equipment.

Job Description

As an aid to understanding the work of the computer technicians, the following tentative job description is offered:

> The role of the computer technician is to test, adjust and repair electronic computers and auxiliary equipment. His work divides into three main areas: a checkout, which includes all the procedures for testing the computer and auxiliary equipment to make sure that the system is ready for operational use; scheduled maintenance, which consists of the maintenance activities, planned in advance and accomplished according to a regular schedule; and trouble shooting, the process of identifying the source of technical malfunctioning in the equipment when in use and then repairing or replacing the defective units or components. In detail, the work includes: location and diagnosis of the causes of defective performanc

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(1) These employees were not interviewed by research organization.

(2) The maintenance arrangements in this particular installation are atypical. The usual practice in EDP installations is to rely completely on the equipment manufacturer to provide engineering and technical maintenance and repair services, whether the equipment is purchased or rented.

(3) Since November 1960 the computer has been utilized on a three-shift per day/five-day week basis plus occasional weekend overtime.

of electronic circuits and assemblies, using such testing devices as oscillators, signal generators, and oscilloscopes, following schematic diagrams or verbal instructions; the repair and adjustment of equipment by rewiring components, soldering loose connections, and replacing such units as condensers, coils, or resistors, using electrician's hand tools; and performing a wide variety of preventive maintenance duties, including mass tube replacement, cleaning parts, rewiring new parts into circuit, adjusting phasing and aligning stages. The major responsibility of the computer technician, through thorough regular maintenance and quick remedial action in emergencies, is to keep costly computer down-time to a minimum.

Characteristics

Three computer technicians were recruited from within the establishment. All were long-service employees of the company. Their average age--45--was much higher than that of any other group of employees associated with electronic data processing except for the systems analysis group. The three computer technicians had been with the company for an average of approximately 25 years. They were drawn from senior clerical and clerical supervisory classifications and had been responsible for clerical work entirely unrelated to either mechanical or electronic data processing. None of the technicians had attended university but all three had completed secondary school.

The computer technicians believed that the key to success in their work was a strong interest and a broad background in electronics. They felt that a high school education would be helpful and that a good knowledge of mathematics was important. A quality that they stressed in common with the computer programmers and operators was the need for a good analytical type of mind. In addition, they emphasized the value of manual dexterity and patience.

Selection and Training

The basis of selection in the case of the three company employees chosen for training as computer technicians was quite different from that of the programmers or other occupational groups in the Computer Centre. None of the three had ever worked in the Punch Card Department. In each case, the basis for selection appeared to have little or nothing to do with their extensive clerical and clerical supervisory experience in the company, but was related rather to knowledge and skills acquired outside their jobs. In two cases these skills had been acquired through radar work in the Armed Forces and in the third case through extramural study in radio and electronics to further an avocational interest. As one of the technicians explained:

> '...I was an office man. All the (computer manufacturers) resident engineers and technicians are technical men by training and jobs. We're converts. It's only because we have had similar interests and done similar work on the side. Nothing we have done in the company previously has had any real application to the new work.'

Another aspect of the technicians' selection, which tends to set them apart from others in the Computer Centre, was the active manner in which each sought out his new assignment, drawing the relevance of his outside experience to the attention of management.

None of the three computer technicians had served the extensive progressive 'apprenticeships' on sorters, collators, reproducers, accounting machines and other mechanical tabulating components that had constituted the basic data processing experience for other occupational groups in the Computer Centre. Their transition to EDP occupations, as far as their occupational history with the company is concerned, was a direct one from clerical jobs to maintenance on the large-scale computer.

These new assignments were preceded by extended periods of formal classroom and practical training that exceeded in duration and depth any training taken by any of the other EDP occupational groups, including the programmers. The course in Computer Logic and Maintenance lasted five months and was taught by computer manufacturer's instructors on the computer manufacturer's premises. This course did not include instruction in basic electronics, a thorough knowledge of which was assumed on the part of the candidates. The course content covered the logic of the functioning of the computer, the electronic circuitry of the computer, and practical techniques used in preventive maintenance and trouble shooting. Later, the technicians took an additional four-week course on the maintenance of peripheral equipment components--the card-to-tape converter and the high-speed printer. In addition to these formal training courses, however, the computer technicians continue to enjoy a rather unique training situation on the job by being associated in their work with the manufacturer's resident technical staff.

Attitudes of Computer Technicians Toward Their Work

The technicians felt that the level of difficulty of their work had increased considerably over their previous jobs. However, all the computer technicians had welcomed the news of their selection, regarding it as a promotion or an opportunity for promotion, and all of them preferred their present work to previous jobs because it was 'like getting paid for doing your hobby'. After several months on the job it was quite clear that they were finding their EDP assignments intrinsically interesting and satisfying. The only disadvantage pointed out by the computer technicians was that their new job involved working at nights.

Future Plans

All three computer technicians planned to stay in their new line of work permanently.

Chapter VI

Other EDP Occupations

The three peripheral equipment components in this EDP installation are: a high-speed printer, a card-to-tape converter, and a tape-to-card converter. These machines are run 'off-line' from the main computer. At present, a small team of three operators is responsible for running the peripheral equipment. An informal group supervisor has been trained on all three components. One of the operators is responsible for the operation of the card-to-tape converter, and the other for operating the high-speed printer. In practice, there is a high degree of interchangeability of task among the members of this group, depending upon which component has the greatest work load at the moment. The tape librarian is included in this section as he previously was trained on all the peripheral equipment and, in turn, instructed the present peripheral equipment operators.(1)

As an aid to understanding the work of the peripheral equipment operators, the following tentative descriptions are offered:

Card-to-Tape Converter Operator (and Tape-to-Card Converter Operator)

The card-to-tape converter operator must have a detailed working knowledge of the capacity and performance characteristics of the card-to-tape converter, and a general familiarity with the purpose and pattern of functional relationships of the computer and the various components of the EDP installation.

Job Description

The role of the card-to-tape converter operator is as follows:

> To operate a component that automatically transcribes data from punch cards to magnetic tape in order to provide acceptable input for the computer. In detail, this role involves studying instructions for the job to be done, positioning the card input and mounting magnetic tape reels on tape units to receive the output; setting the controls on the component, which may involve wiring plugboards and making circuit connections; starting the machine; monitoring the converter in operation for evidence of malfunctioning; recognizing and rectifying elementary sources of malfunctioning such as a blown fuse; reporting serious malfunctioning to supervisor or technical staff; dismounting, identifying and distributing output; and filling in appropriate production records. The incumbent may also operate other peripheral components in the system.

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(1) This experience is probably restricted to the case under study. It should not be inferred that experience in operating auxiliary equipment is in any way prerequisite to the tape librarian function. (Refer to job description--Tape Librarian.)

High-Speed Printer Operator

The high-speed printer operator must have a detailed working knowledge of the capacity and performance characteristics of the high-speed printer and a general familiarity with the purpose and pattern of functional relationships of the computer and the various components in the EDP installation.

Job Description

The role of the high-speed printer operator is as follows:

> To operate a component that converts information provided by the computer in the form of reels of magnetic tape into printed records. In detail, this role involves studying instruction sheets; mounting tapes on tape units and positioning paper stock to receive output; 'setting' the machine, which includes inserting the appropriate plugboards and positioning of controls and may involve wiring plugboards and making circuit connections according to prepared diagrams; starting the machine; monitoring the machine during operation for legibility and correct format of output and observing neon lights for evidence of malfunctioning or error situations; recognizing and rectifying elementary causes of malfunctioning; reporting serious malfunctioning to supervisor or technical staff; returning tape reels and distributing printed output; and filling out appropriate production records. The incumbent may also operate other peripheral components in the system.

Tape Librarian

The tape librarian must be familiar, in a general way, with the purpose and pattern of relationships between the various elements of the EDP system and, preferably, should have experience in or knowledge of basic library skills.

Job Description

The tape librarian's role is as follows:

> To maintain a library of the reels of magnetic tape used in the system. In detail, his role involves classifying and cataloguing reels of tape; issuing instruction, input and blank tapes for output and maintaining charge-out records; receiving, inspecting, and carrying out necessary physical maintenance on returned tapes, and sorting, re-labelling, filing and storing reels of tape when not in use.

Characteristics

All the peripheral equipment operators were recruited from within the establishment. All four were young men, with an average age of 24 years. All were relatively short-service employees, with less than 10 years in the firm. All four were drawn from a background in the Hollerith Department.

During the course of three or four years in that Department, they have moved from the operation of the simpler to the more complex conventional punch card processing machines and had become thoroughly familiar, through on-the-job training, with the mechanical tabulation process. All the peripheral equipment operators had considerable secondary school education, the average level of formal education achieved being 3.6 years.

The peripheral equipment operators believed the characteristics that contributed to success in their work included mathematical aptitude, manual dexterity, patience, and steady nerves. They placed much less emphasis than the other groups on the need for formal education and stressed that the key to success was extensive practical experience in mechanical tabulating work.

Selection and Training

From the remarks made by respondents, it seemed quite clear that they attributed their selection to their thorough knowledge of and experience in operating the battery of conventional punch card machines in the Hollerith Department. No formal selection machinery was used in choosing the peripheral equipment operators. The training of the peripheral operators consisted entirely of informal on-the-job training and practice operating under supervision.

Attitudes Toward Peripheral Equipment Operating

Generally, the peripheral equipment operators felt that the level of difficulty of their present assignment represented an increase over their previous jobs in the Hollerith Department, although this apparently was not experienced as so sharp an increase as in the case of the programmers or computer technicians. All the peripheral equipment operators had received the news of their appointment to their new EDP assignments with pleasure, regarding it as a promotion or an opportunity for future promotion.

Attitudes Toward Future

Each of the peripheral equipment operators hoped to make his career in the electronic data processing field. One looked forward to moving up to operate a more complex piece of peripheral equipment; one foresaw a possibility of being promoted to supervise the peripheral components or to learn to operate the large-scale computer; one looked forward to being trained either as a computer technician or a large-scale computer operator; and the fourth hoped to be selected as an operator on the big computer.

Data Typist

Another EDP occupation which should be mentioned, is that of data typist. A group of three female employees were operating data typing machines and plans had been made to train an additional group of girls in data typing work. As the data typists had just begun their jobs, they were not interviewed by the research organization.

The 'unityper' machine is a typewriter-like device used to transfer information from source documents directly onto magnetic tape to provide input for the computer. This occupation is intimately related to that of typist or key-punch operator. The essential skills are general intelligence, manual dexterity, accuracy, and speed. Data typists will typically be selected from typists and/or key-punch operators. Training will typically be on-the-job training. Training will be in the nature of conversion training, because the purpose of such training will be to familiarize candidates with a slightly different keyboard layout and modified characteristics of the machine itself.

At the time the research was carried out, the need for accuracy in this occupation was the paramount consideration. Since that time, magnetic tape verifiers have been introduced which provide an opportunity to check the accuracy of input before it is consigned to the computer.

Appendix

Programmer/Operators (Medium-Sized Computer)

About two years before the installation of the large computer, the company had acquired an IBM 650 card input medium-scale computer.(1) They also had a small 'computer'--an IBM 604 electronic calculator. It appeared to be generally understood that this equipment had been acquired as a transitional measure and would be dispensed with when the large-scale computer came into full production. In this section, we will treat the three programmer/operators of the medium-sized computer and the programmer/operator of the small computer as one group. The majority of the large-scale computer operators and several of the programmers had been introduced to electronic data processing via the medium-sized computer. The present staff of the medium and small computers had been in their present jobs for less than a year when they were interviewed.

The personnel engaged on this work combine the functions of both programming and operating. It may be that in other installations, particularly where the computer is tape fed and fitted with on-line peripheral equipment, the work of programming the medium-sized computer may be kept separate from operating. As the job has two facets, it may be considered more or less difficult than straight programming or operating assignments on a large-scale computer. The job is more difficult in the sense that the incumbent must have a knowledge of both programming and operating, and less difficult in the sense that the requisite knowledge for each job is less extensive than would be the case of either job in relation to the big computer. A composite description of this job can be derived from descriptions of the previous two jobs, modified in both aspects by the less complicated equipment.

The programmer/operator of the medium-scale computer must be familiar with or have access to detailed knowledge of the particular procedures he is to program for conversion to and for operation on the electronic data processing equipment. He must also have a detailed working knowledge of the capacity, capabilities and logical operation of the computer.

Job Description

As an aid to understanding the work of programmer/operators on the medium-sized computer, the following tentative job description is offered:

> The role of the programmer/operator of a medium-scale computer is to prepare detailed instructions according to which data may be prepared for input to the computer, step-by-step instructions according to which the computer may carry out the steps necessary to process such data, and detailed instructions to control the format and quality of the output. The preparation of such instructions may take the form of detailed or

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(1) As planned, the use of this computer was discontinued in February 1960 after the large-scale computer had been brought into extensive operation.

simplified flow charts. The programmer then proceeds to code the programs he produces. Coding involves the translation of programming instructions into the digital vocabulary acceptable to the computer. When coded, the programmer tests his program on the computer to ensure that it is comprehensive and accurate. Any mistakes or deficiencies must be rectified. This process is called 'de-bugging'. Depending on the nature of the subject matter to be programmed and the extent and complexity of the processing involved, programming may vary widely in level of difficulty. In addition to programming, the programmer/operator monitors and controls the operation of the medium-scale computer on test and production runs by operating a control unit known as a console. In detail, this involves studying the instructions for the run to be processed, stacking the card input and positioning blank cards for output, setting the appropriate controls on the console, clearing the computer memory, starting the computer into operation, monitoring the computer in operation by observing patterns of neon lights on the control console, attempting to determine and correct the cause of stoppage or error situation when such situations occur, reporting to supervisor or consulting with computer technician when stoppage or error situations involve program logic difficulty or machine failure beyond his competence to rectify, taking steps to recover or re-run program after stop or error situations have been rectified, taking off and distributing input and output at the end of the run, and filling out appropriate production records.

Characteristics

All the programmer/operators were recruited from the Hollerith Department in the company. They are all young men with an average age of 25 years who had achieved senior clerk classification in their previous jobs. Their average level of formal educational qualifications was much higher than for any of the other EDP occupations, two having completed university degrees and the other two having completed senior matriculation. They were employees with only a short period of service (less than 10 years) with the firm, of which two had been with the establishment less than two years. The programmer/operators shared much the same opinion as the large-scale computer programmers about the characteristics that were necessary for success in their work. They stressed the necessity of a problem solving type of mind, strongly individualistic temperament and personality, and they put a good deal more emphasis than the others in the Computer Centre on formal educational training, including college education, particularly in mathematics.

Selection and Training

The programmer/operators believed that previous experience on conventional punch card accounting machinery had been a factor in their selection. But such Hollerith experience had only been extensive in the case of one of the respondents. Two of the respondents had had experience in programming and operating the electronic calculator and mentioned this

experience as a partial explanation of the logic of their promotion to their present assignments. One of the respondents had apparently been hired as a programmer/operator on the medium-sized computer without previous experience and had been given a short four-month initial familiarization period on two of the component machines in the Hollerith Department. Along with one of the other programmer/operators he felt the level of formal education he had attained had probably had a direct effect on his selection.

Through informal, on-the-job training over the course of an average of three or four years in the Hollerith Department, these employees had moved from the operation of simple to the more complex electro-mechanical components. The course of instruction which they took in preparation for their assignments as programmer/operators of the medium-sized computer was the first formal classroom training which they had experienced on electronic data processing work. This was a two-week course offered on the premises of the manufacturer and taught by an instructor supplied by the manufacturer. The course involved the theory of operating but the greatest proportion of the instruction was allocated to programming--working through the programming manual published by the computer manufacturer. Although there was no computer available for demonstration and practice on this course, the big advantage that those in this group enjoyed over their predecessors in the company who had taken this course was that the company's medium-scale computer had been delivered by this time, and that, before leaving on the course, those selected had spent some time observing it in operation. The respondents felt that this familiarity had helped them considerably in following and assimilating the information offered on the course. Even so, however, it was clear that a critical part of the learning process involved on-the-job practice on the computer when they returned from the course and began to utilize the theoretical knowledge they had gained by translating it into the practical techniques of developing and running applications on the computer. This group also had the advantage that their initial months on their new job was supervised by people previously trained on this work and who were now preparing to move into new assignments on the big computer.

Attitudes Toward Programming and Operating the Medium-Sized Computer

Unlike the large computer operators, the programmer/operators of the medium computer felt that the level of difficulty of their present job was considerably greater than on previous jobs. In spite of this, however, these employees regarded their selection as a step up and three out of four were enthusiastic about their electronic data processing work, particularly the programming side of it. Their only complaint was that the operating side of their job was tedious. As one explained:

> '...what I dislike is the operating. Of course, there is a certain amount of satisfaction in eating up a pile of undone work. But once you have started to feed it and everything is going smoothly, it can be very dull. Yet if something does go wrong, it is likely it is something wrong with the machine or the other fellow's program, and the delay is very frustrating.'

Attitudes Toward Future

Three out of the four programmer/operators of the medium computer plan to make their careers in the EDP field. Aware that the computer on which they were working would probably be dispensed with in about a year's time, they tended to see their promotional possibilities in terms of new assignments associated with the large-scale computer. On the assumption that the large-scale computer installation would need additional personnel as its operations expanded, two of the respondents expressed the hope that they would be able to move into programming for the large-scale computer.

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